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**Advancing 21st Century**
**Forest Based Economy through**

# FBRi

## Forest Bioproducts Research

Managing Director: Dr. Hemant Pendse

Scientific Director: Dr. Stephen Shaler

NSF EPSCoR

# FBRi Vision

***To advance understanding about the scientific underpinnings, system behavior, and policy implications for the production of forest-based bioproducts that meet societal needs for materials, chemicals and fuels in an economically and ecologically sustainable manner***

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# New Business Opportunity

- Forest Landowners
- Biomass Power Plants
- Sawmills & OSB plants
- Pulp Mills

**Imagine what we can do together**

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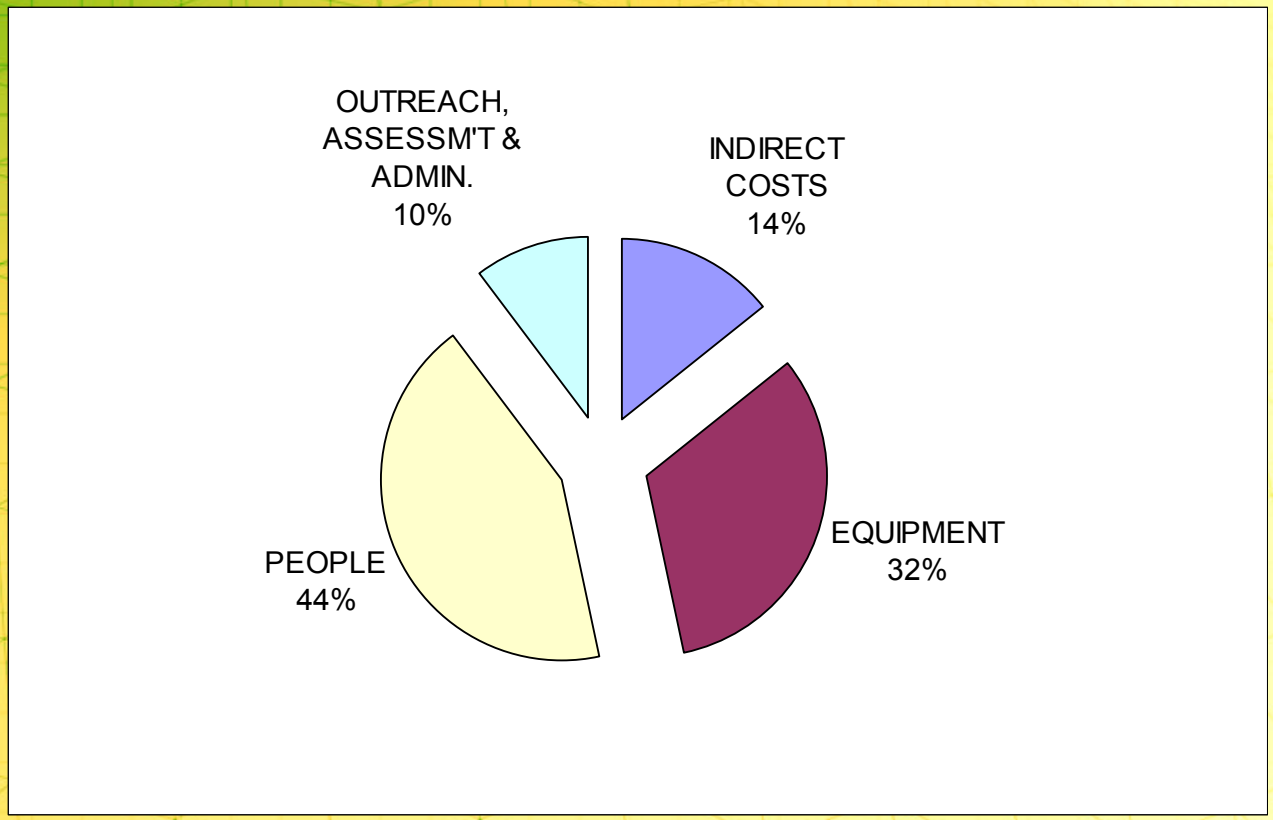
# $10 Million Investment in Research Infrastructure

## Ideas




PEOPLE

NEW HIRES

3 Faculty
4 Postdocs
2 Techs
3 Admin Staff
12 Grad Students
24 UG Students

## People

## Tools

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# Permanent Equipment

| | EQUIPMENT BUDGET | | AMOUNT |
|---|---|---|---|
| 1 | ***Chemical Analysis Laboratory*** | | $600,000 |
| 2 | ***Thermal Analysis Laboratory*** | | $185,000 |
| 3 | ***Microscopy Laboratory*** | | $250,000 |
| 4 | ***Fermentation/Biocatalysis Laboratory*** | ➲ | $1,000,000 |
| 5 | ***Biomass Processing Laboratory*** | ➲ | $1,000,000 |
| 6 | ***New Hire Start-Up etc.*** | | $315,000 |
| | **TOTAL** | | $3,350,000 |

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# Innovation/Technology-based Economic Development for the "New Economy"

| | Basic Research | Applied Research | Development & Commercialization |
|---|---|---|---|
| Science & Technology Development | | | |
| Industrial Problem Solving | | MAFES PDC | MAFES PDC |
| Technology Financing | | MTI seed grants | MTI development awards |

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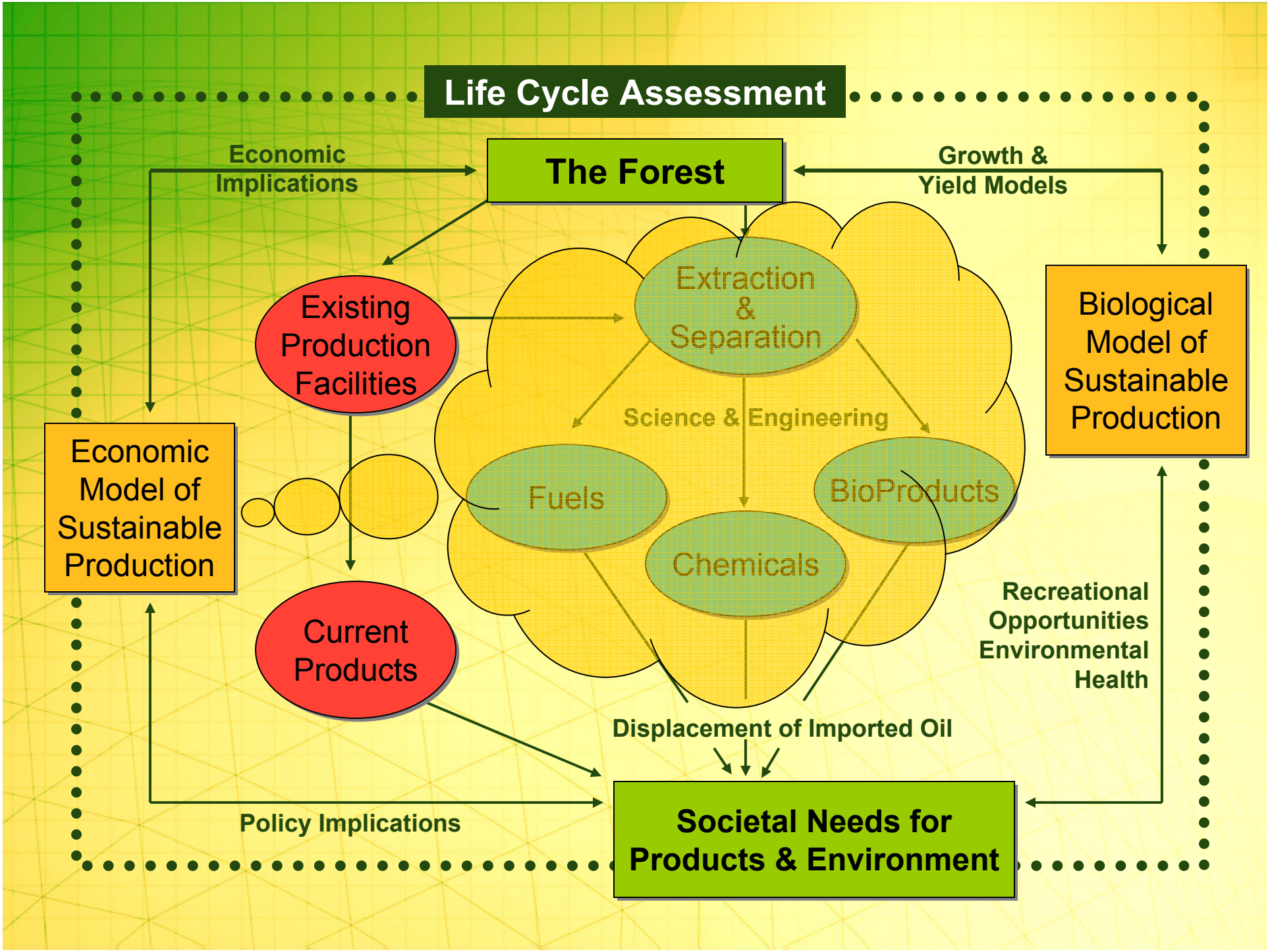
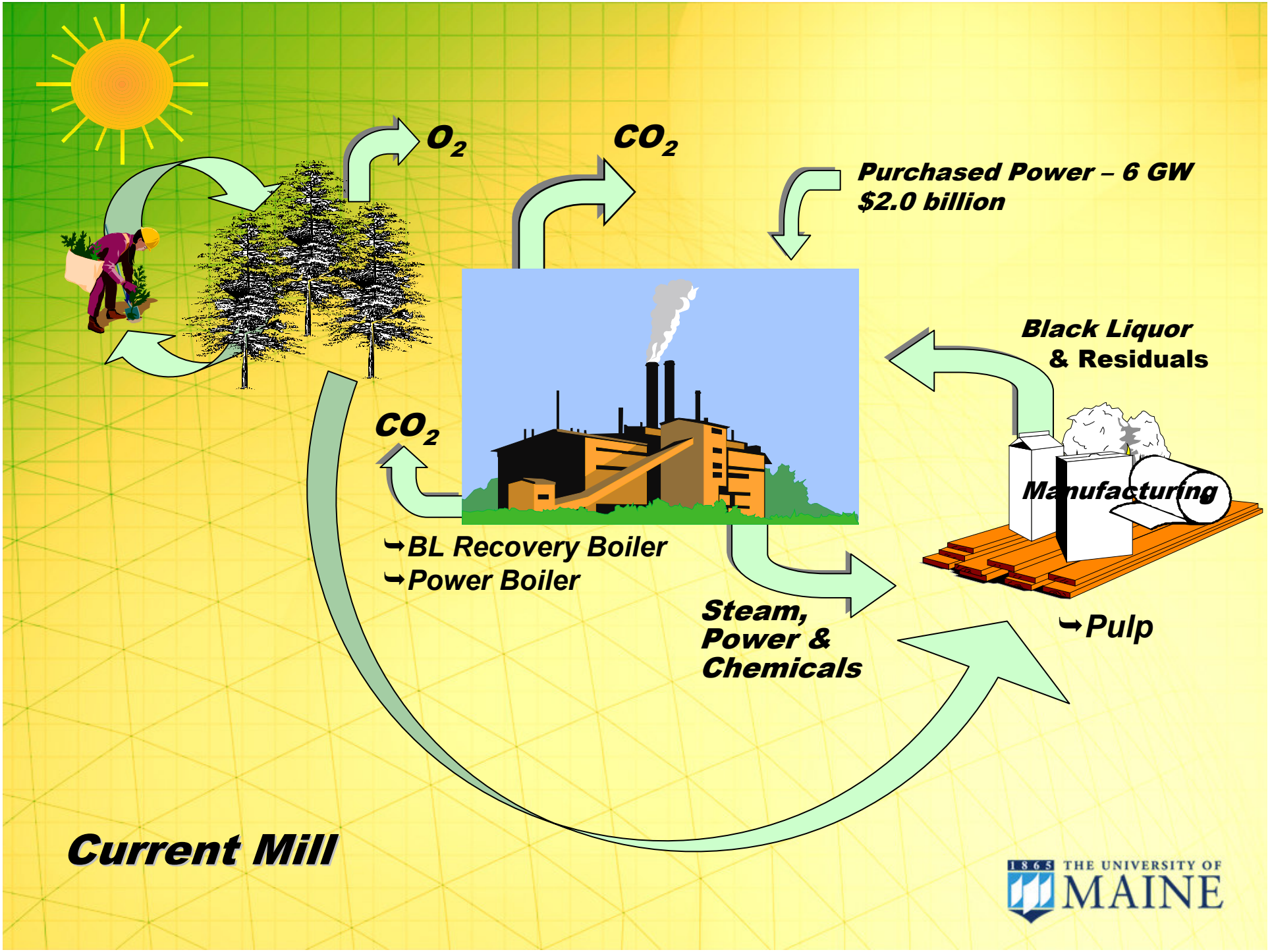

Life Cycle Assessment
Economic Implications
The Forest
Growth & Yield Models
Existing Production Facilities
Extraction & Separation
Biological Model of Sustainable Production
Science & Engineering
Economic Model of Sustainable Production
Fuels
BioProducts
Chemicals
Current Products
Recreational Opportunities Environmental Health
Displacement of Imported Oil
Policy Implications
Societal Needs for Products & Environment


$O_2$
$CO_2$
Purchased Power – 6 GW
$2.0 billion
Black Liquor
& Residuals
$CO_2$
Manufacturing
➥BL Recovery Boiler
➥Power Boiler
Steam,
Power &
Chemicals
➥Pulp
Current Mill
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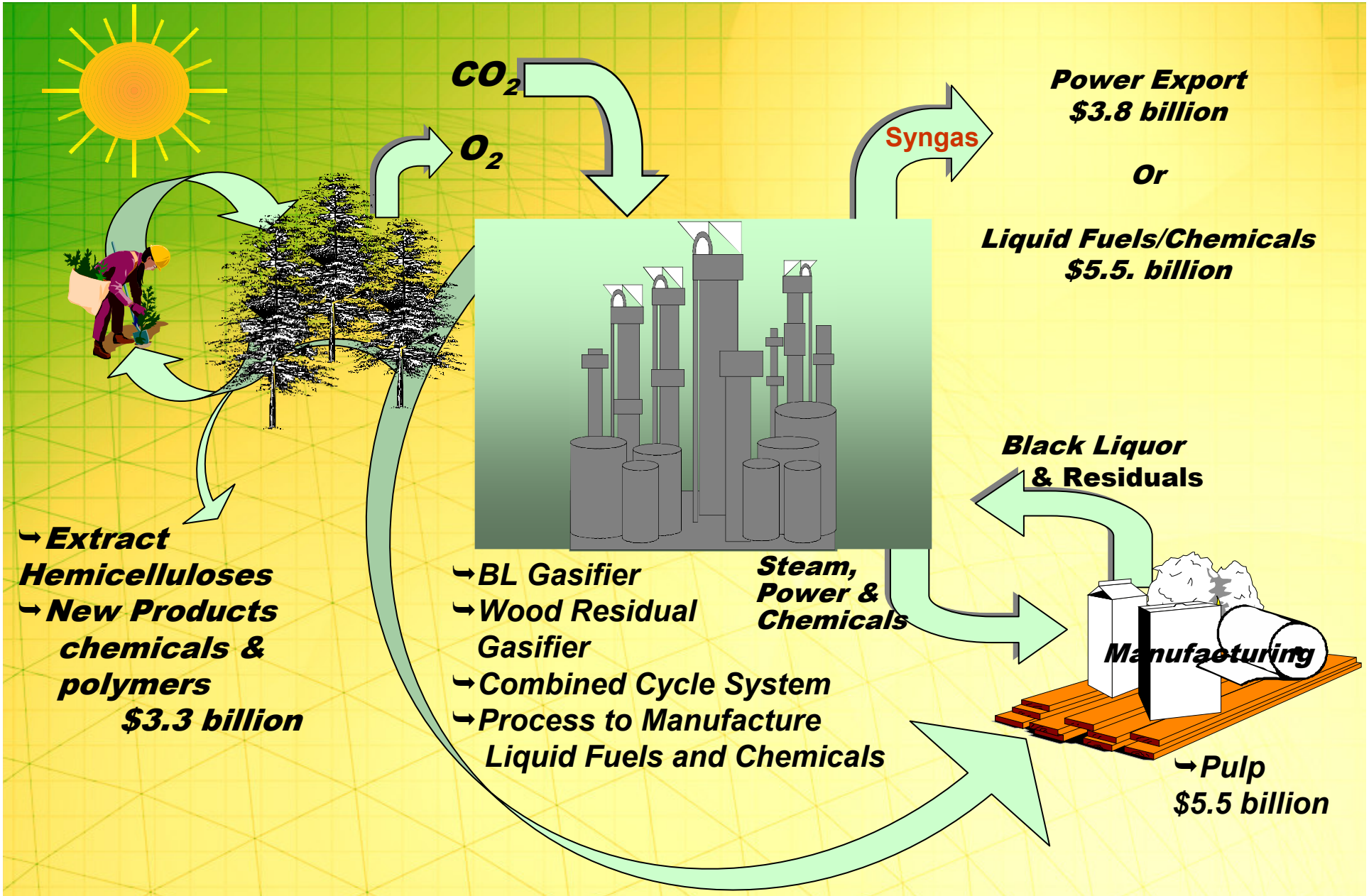


# The Forest Biorefinery – Net Revenue

**Net Revenue Assumptions:**

| | |
|---|---|
| Acetic Acid - $1.73/gallon | Purchased Electricity - $43.16/MWH |
| Ethanol - $1.15/gallon | Exported Electricity - $40.44/MWH |
| Pulp - $100/ton net profit | Renewable Fischer Tropsch Fuel - $57/bbl |

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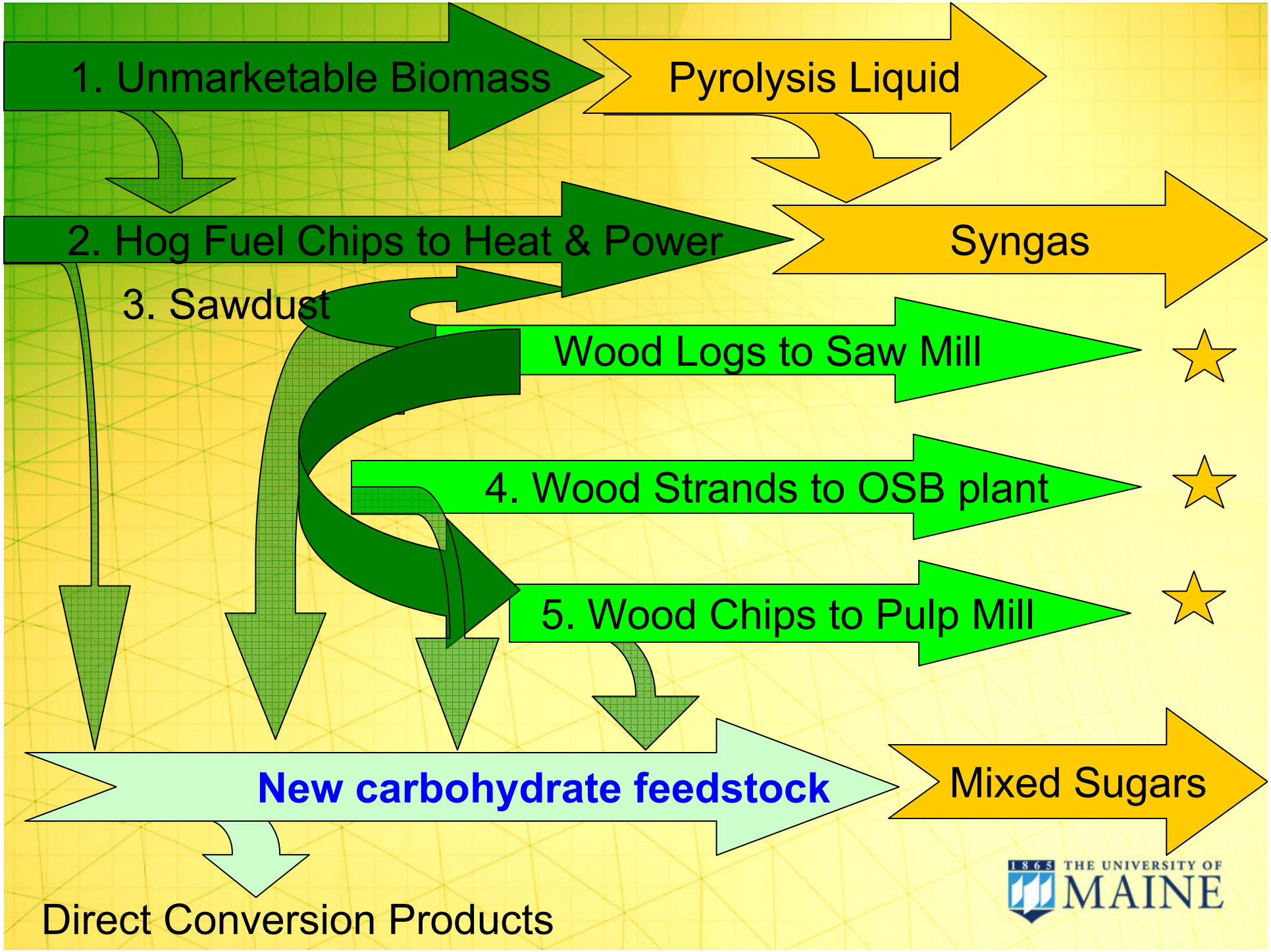
1. Unmarketable Biomass
Pyrolysis Liquid
2. Hog Fuel Chips to Heat & Power
Syngas
3. Sawdust
Wood Logs to Saw Mill
4. Wood Strands to OSB plant
5. Wood Chips to Pulp Mill
New carbohydrate feedstock
Mixed Sugars
Direct Conversion Products
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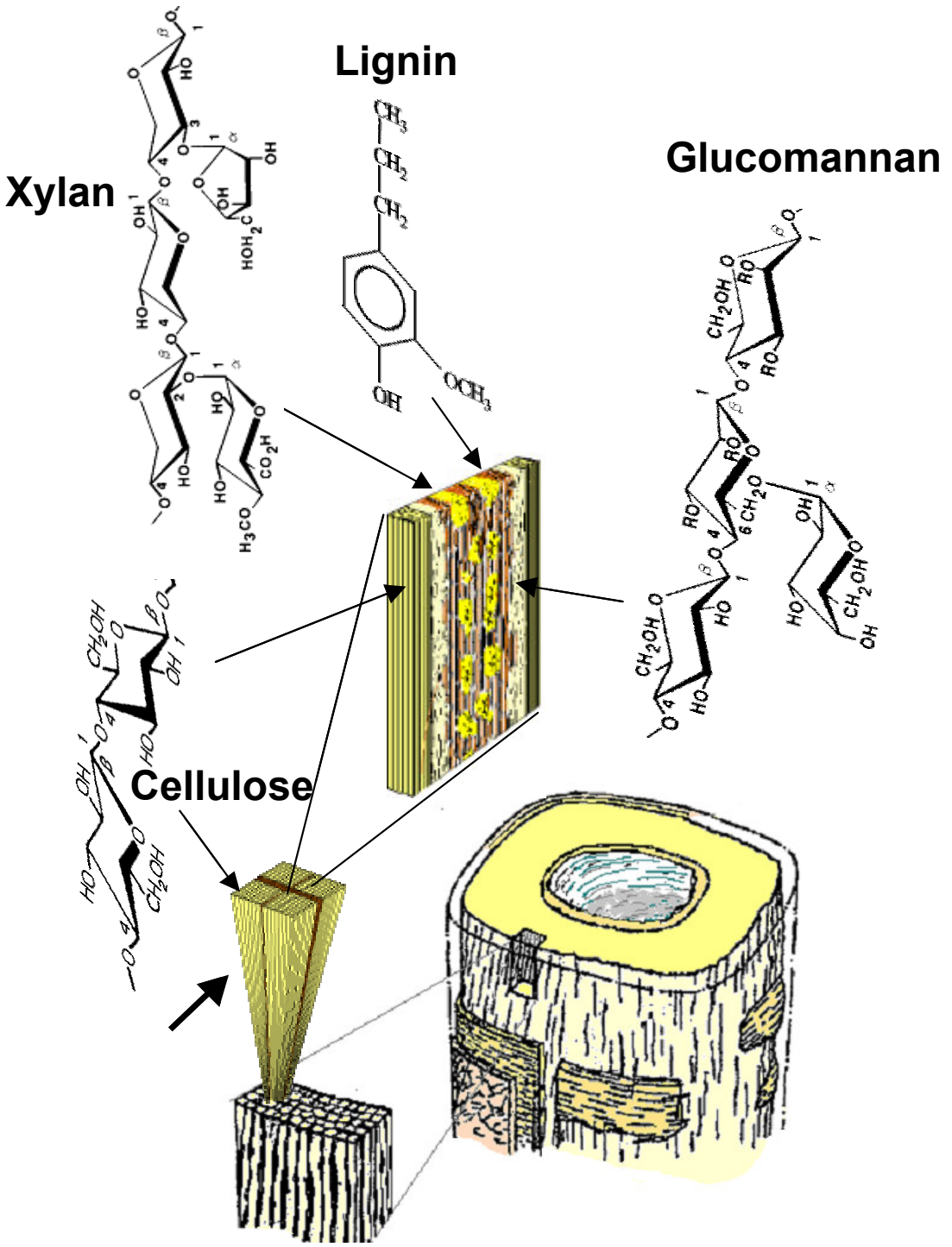
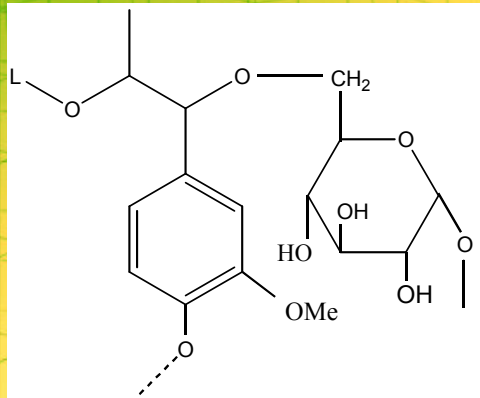
# Wood Components

**Xylan and glucomannan are hemicelluloses**

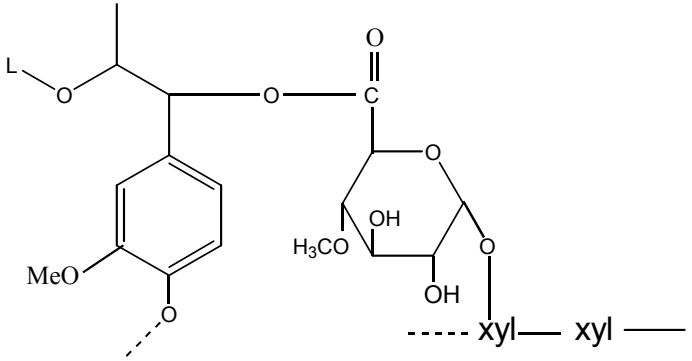
M. Åkerholm and
L. Salmén, STFI 2004



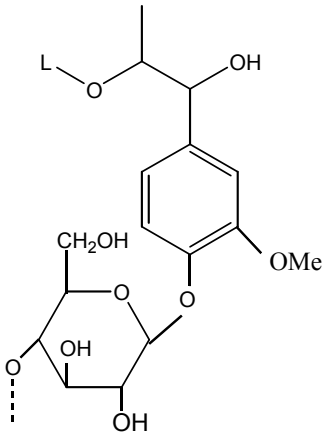
# Lignin-Carbohydrate (LC) Bonds



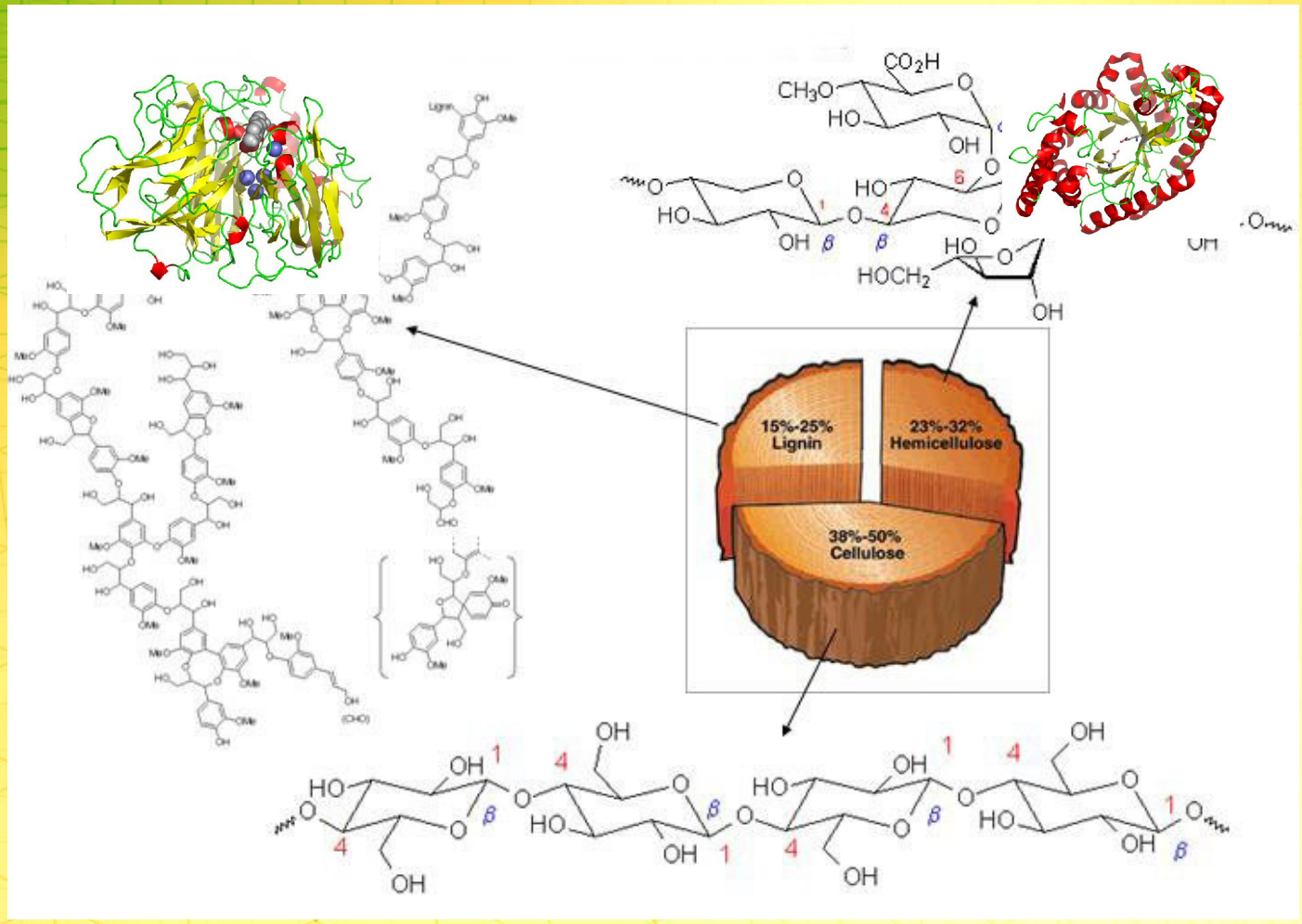

Benzylether LC-bond




Benzylester LC-bond




Phenylglycoside LC-bond




INSTITUTE FOR MOLECULAR BIOPHYSICS

Functional Genomics

NSF EPSCoR

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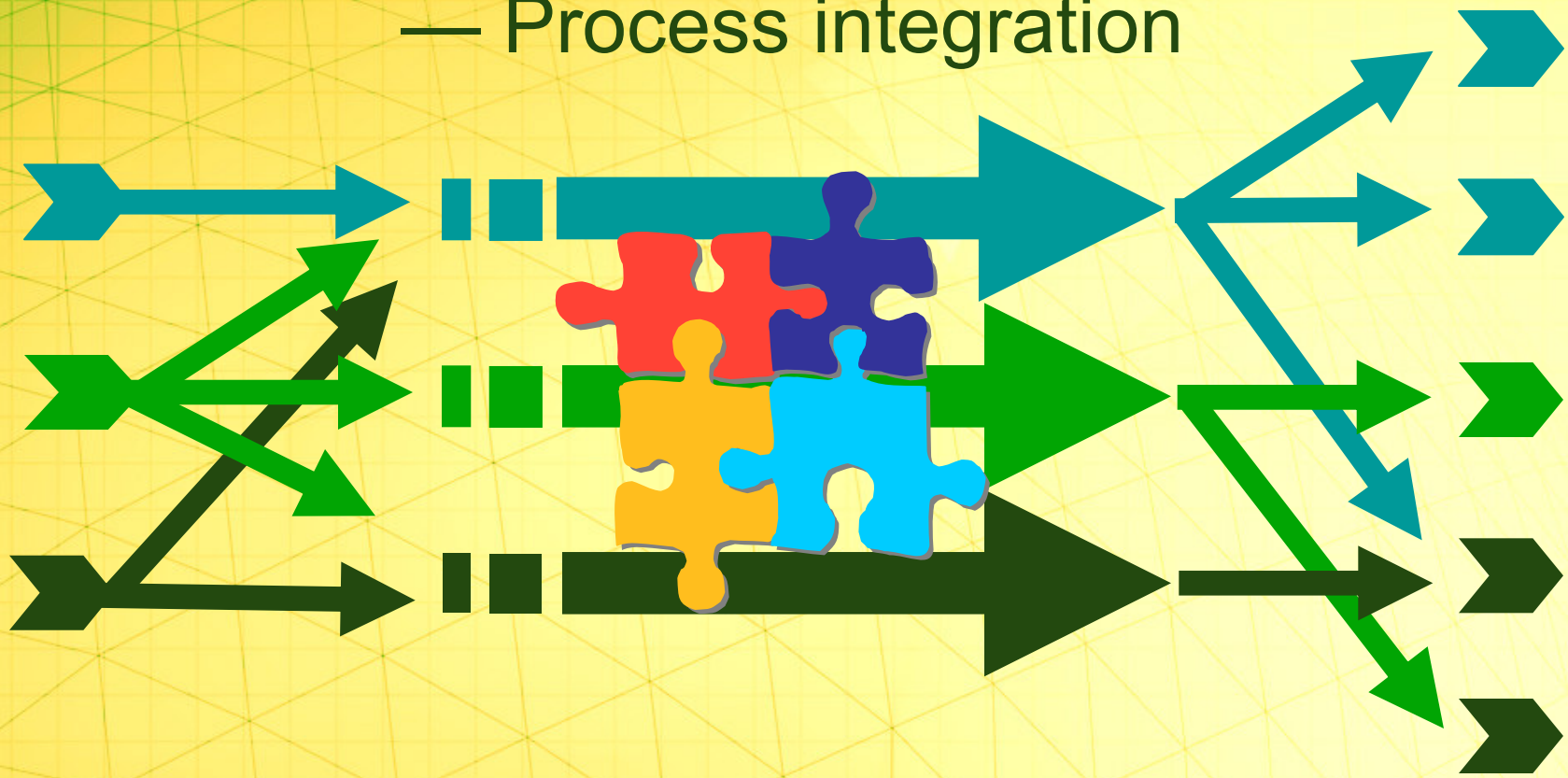
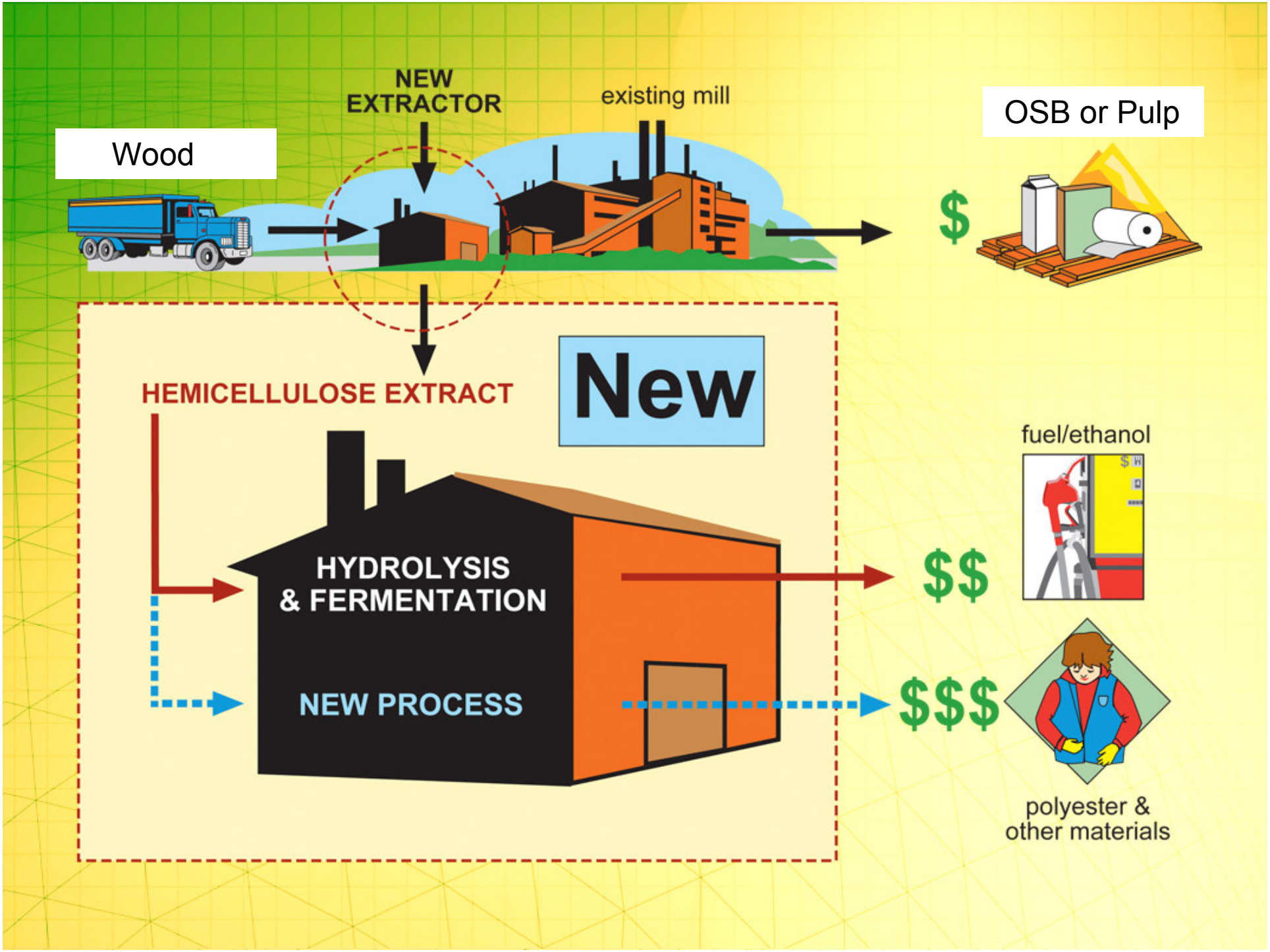
Biomass to Biofuels
Woody Biomass
New Carbohydrate Feedstocks
Novel Well Characterized
Purified & Concentrated
Wood Extracts
As High Impact Feedstocks

# Integrated Forest Biorefinery Platform

- Multiple feedstocks
- Adjustable product mix
- Process integration




NEW
EXTRACTOR
existing mill
Wood
OSB or Pulp
$
HEMICELLULOSE EXTRACT
New
fuel/ethanol
HYDROLYSIS
& FERMENTATION
$$
NEW PROCESS
$$$
polyester &
other materials

# The Case for the Wood

- Available year round and easily stored
- High density is positive for shipping
- Low in ash and sulfur content
- Can sustain and enhance rural economic development
- Does not compete with food or animal feed markets
- Much better energy ratio for ethanol production
- Well-developed infrastructure exists for growth, harvesting, transportation and processing
- In many areas, wood processing facilities are located near agricultural activities offering co-processing opportunities

# New England Green Chemistry Program Consortium (NEGCC)

- **University of Maine (Lead Institution)**
  - Extraction of Biomass Components
- **University of Massachusetts, Amherst**
  - Purification and monomer conversion
- **University of Connecticut**
  - Polymer Processing
- **University of Vermont**
  - Polymer Characterization
- **University of Rhode Island**
  - Sustainability and Life Cycle Analysis
- **University of New Hampshire**
  - Applications of New Materials
- **University of Massachusetts, Lowell**
  - Environmental Considerations

**We have regional platforms.**

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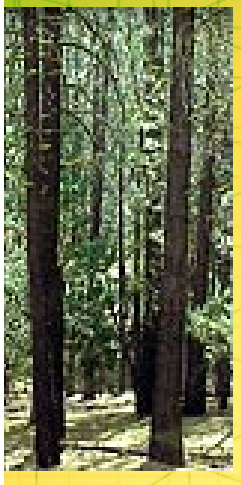
# Resource Plan



**Research Infrastructure**

NSF EPSCoR
$10M

Research Personnel
Bench/Lab Scale
Analytical
Batch Processes

**Pre-Processing Center**

State R&D Bond
& Private Funds
$5M

Large Scale
Pre-treatment,
Hemi Extraction
and/or
Thermochemical
Treatment
of Biomass

**Integrated Biorefinery Semiworks Demo Plant**

Private Funds/Govt Grants
$20-$200M

*Co-located at:*
Co-Gen site
Pulp mill
OSB/OSL Plant
Saw Mill
Industrial Cluster

**Forest Bioproducts Technology Development**

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http://www.forestbioproducts.umaine.edu/

Industry and business leaders have an opportunity to get a seat at the table for advice, collaboration and direction.

Become a founding member of the Forest Bioproducts Research Institute.

E-mail: forestbioproducts@maine.edu

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